Exploring Attosecond Dynamics *via* Angular Streaking at Free-Electron Lasers

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The field of attosecond physics has recently been extended from ultrafast laser laboratories to free-electron laser sources. This allows novel paths of investigation, like site-specific exploration of electron dynamics in molecules or time-resolving nonlinear X-ray excitation dynamics. To fully capitalize on the opportunities provided by these new tools, strategies to characterize the usually stochastic X-ray pulses have to be developed and implemented. We describe the method of angular streaking in combination with machine learning techniques as a way to achieve single-shot time–energy information about the FEL pulse structures and report on first measurements with sub-femtosecond pulses at the European XFEL. Hints of two-photon double core excitation processes in neon within single XFEL shots and the dependence of their dynamics on the spike separation of the X-ray pulses are presented.

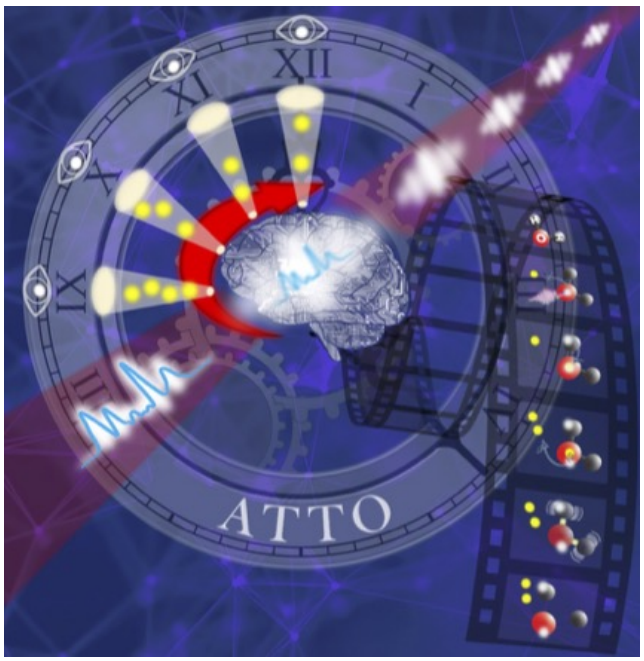

Figure 1: Intelligent Angular Streaking. The figure sketches the main idea of the described approach for attosecond physics at FELs: The stochastic FEL pulse structure is made available for each shot by an angular streaking measurement in conjunction with a machine-learning-based retrieval, and the acquired precise trigger knowledge is used for the interpretation of the initiated ultrafast dynamics in the observed system

This work was achieved in a huge worldwide collaboration with the following coworkers:

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